WATER POWER
IN
NEW YORK STATE

What its Development
will mean for the public

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November 20, 1926

WATER POWER IN NEW YORK STATE

The enclosed booklet entitled "Water Power in New York State" gives information relating to this important subject which thoughtful citizens may find useful in forming their conclusions as to the best means of utilizing some three million horse power now going to waste in this state.

There seems to be no dissent from the belief that unused but available water power should be harnessed and put to work in the interest of the public. Coal supplies are not inexhaustible and should be conserved. Intelligent utilization of water power is one means of postponing the day when coal can not be had.

Shall the state develop these water powers or shall public utilities be entrusted with the task?

This booklet, prepared by the Empire State Gas & Electric Association, frankly upholds the latter position. We are pleased to send you a copy in the belief that it will be a contribution to whatever fund of information you may have on the subject.

OYL 2924 Box 37

WATER POWER IN NEW YORK STATE

WHAT ITS DEVELOPMENT WILL MEAN FOR THE PUBLIC

OYL 2924 BOX 37

Niagara Falls

WATER POWER
IN
NEW YORK STATE

WHAT ITS DEVELOPMENT WILL MEAN FOR THE PUBLIC

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Foreword

Applications for licenses to develop large water powers are being considered by the Water Power Commission of the State of New York. This book is a statement by the electrical industry of New York State of the facts in the situation and the economic considerations which make desirable a prompt and systematic utilization of the great natural resources now going to waste in the Empire State.

It is the industry's duty to furnish an abundant and economical supply of electrical energy and to have it always ready in advance of demands. The interests of the public and of the industry coincide in requiring the prompt beginning of comprehensive development of the water power in the State, available but unused.

The electrical industry, which has already put to work 1,750,000 horsepower of water power in serving the people of New York, stands ready to harness this unused water power. Some of it, where no legal obstacles prevent, is being developed now. Development of the bulk of it, however, must await authorization by various official bodies and Governments. If and when such authorization can be obtained, the electrical industry is prepared to undertake the engineering and financing tasks, of unequalled size and difficulty, involved in the projects. It has the plans. It has the men who can carry them to success. It can get the money—and before it gets back one cent in revenue it will be required to spend hundreds of millions of dollars on some of the developments.

I Resources Now Wasted and Their Possibilities

IN New York State there is unused but available for development water power aggregating more than three million continuous horse power. This is almost as much as the present total of electrical generating capacity in the State, both water power and steam.

These unused resources fall into two natural divisions—power from the international boundary streams, Niagara and the St. Lawrence; and power from interior streams.

On the International section of the St. Lawrence 2,400,000 horsepower can be developed, half of which would be available for New York State.

At Niagara 1,000,000 horsepower additional can be developed without injury to scenic beauty.

From the interior streams 1,000,000 horsepower additional can be developed.

This three million horsepower does not represent the total power possibilities of the streams of the State. It represents only projects carefully studied, which can economically be converted into power and which electrical companies if authorized are ready to develop and put to work as a needed addition to the present power systems in the Empire State.

Put to work, this water now flowing idly to the sea can benefit mankind socially and economically. If New York State is to advance in its industrial leadership and to maintain its progress unchecked, this water should be pressed into service at the earliest possible moment. Power requirements in the State, which already uses one-sixth of the electricity produced in all of the United States, are rapidly increasing. The power supply for homes, farms, stores and factories must ever be well in advance of the demands if industrial progress and community development are not to be handicapped.

From coal or water, or both, must come the power which vitalizes our daily life.

In using water power to the maximum, two great economies are effected—a saving of coal and its by-products and a saving of power otherwise wasted and lost. New York State has the water. It has to import the coal.

There has been for several years a distinct downward trend in rates charged for electricity in New York State. Several elements have contributed to this. About one-third of all the electricity now sold in the State by utility companies is produced at Niagara Falls at very low cost. While considerably more than half the electricity produced in the State is steam-generated, unit costs of production have been reduced by notable improvements in coal burning and increased efficiencies of large size generators. Interconnection of electrical companies has effected economies of operation and administration.

A large part of the potential water power in the State can be developed so that the power will cost less, at the power plant, than electricity now produced from coal. The three million horsepower of the boundary and interior streams can produce power equivalent to the electric energy produced by the burning of twenty million tons of coal yearly. If New York State is to continue mainly dependent on coal for its supply of electrical energy—and steam generated power will always have to furnish a considerable part of the electrical supply for the State—the time will come when power prices will begin to rise because of increased coal costs. Development of the water powers in the State may permit the electrical industry to continue the downward trend of rates for a time. It will, at least, permit a continuance of the present level of prices for a considerable time to come, and thus offer to industry advantages equal to or better than those of any other section of the country.

The effect of development of this water power would be felt in homes and industry all over the State. Because of this new supply of economical power, existing business might be expected to expand and new business to locate within the boundaries of the Empire State. This has always happened when large new supplies of low-priced power have reinforced existing advantages of materials, transportation and markets. Such industrial expansion would increase the number of workers, increase the production of commodi-

ties, increase the size of payrolls, increase the demand for the products of the farms and the merchandise of the stores, increase the value of property and the amount of taxable property.

Put to work, this water power would yield each year an income of many millions of dollars for the State of New York and its communities. It would pay taxes. A large part of it would in addition yield license fees to the State. While the water runs unharnessed, not one cent of this potential income can be collected.

In the development of any or all of this water power, no rights or interest of the State can be surrendered or given away. Where the State has rights involved, they are fully protected by existing laws which require development companies to obtain leases and make adequate payment for them. Before one drop of the water can be harnessed, engineering and financing plans must receive the approval of State officials. Performance of construction work and expenditure of money must be supervised by State officials. The price at which the power generated may be sold to the public will be under the jurisdiction of State officials.

Flat Rock power plant, on the Oswegatchie.

II Why The Waste Goes On

DEVELOPMENT of the major part of the water powers now unused has been prevented for years by a controversy between advocates of State ownership and operation of public utilities and advocates of private initiative and enterprise.

In 1920 the Federal Government adopted a water power act affecting the development and use of all water powers within its jurisdiction. This act, approved by outstanding exponents of sound conservation of natural resources, permits the licensing of individuals and corporations to develop water powers. All licenses are for a maximum term of fifty years, at the end of which the Government may renew the license or at its option grant a new license to a different licensee, or take over—recapture—the development, in either of the two latter cases on payment to the licensee of his actual investment. License fees are provided for; and the licensee must submit to State regulation (or where no State agency exists, Federal regulation) of rates for power sold, standards of service and issuance of securities. In issuing licenses the Commission is required to give preference to applications therefor by States and Municipalities.

While the State of New York owns the beds of the St. Lawrence and Niagara Rivers up to the international boundary, this is not a controlling ownership in power development, and such ownership is subject to the superior rights of the Federal Government with respect to navigation. In addition the State owns lands in the Adirondack Forest Reserve, and on some of those state-owned lands are power sites.

Advocates of State development of water power have contended that the unused water powers are so large and important to the public that no "private interests" should be permitted to handle them. State development has been held out as offering advantages of lower capital costs, lower rates and freedom from possible exploitation of users of electricity. Advocates of development by the electrical industry have pointed out that the State—meaning the Government—was not intended or designed to conduct any business except the business of government itself and that the development

and sale of electric energy is a business, technical, complex and fraught with risk; that the State has no facilities for undertaking such business; that the State would be required to raise and risk an enormous investment. Experience with government ownership and operation of the electrical business elsewhere has proved that the electrical industry in New York is producing water power at lower cost and selling it, unit for unit produced, at lower prices than the government.

In 1921 the legislature of the State of New York finally declared the policy of the State regarding water power development by passing a bill modelled closely on the Federal act. Under this law companies of high technical and financial standing sought authorization to begin developments on the St. Lawrence and Niagara rivers. Official action was delayed and the controversy over the State's policy was renewed by attempts to repeal the law and substitute an indirect form of State development through the agency of a public corporation, a State agency, though not to be permitted to operate by use of the State's credit.

Development of a considerable part of the unused power in the Adirondacks is prevented by another obstacle. The Constitution requires that State lands in the forest preserve shall forever be held as wild forest land. It permits not to exceed three per cent of their area to be flooded for purposes of municipal water supply or for stream regulation. In 1923 there was submitted to the voters of the State for ratification a proposed amendment to the Constitution which would have authorized the enactment of laws providing for the use of this three per cent of the forest preserve lands for the development of water power as well. It would have permitted building of reservoirs, power houses and transmission lines by the State or a lessee of the State under State regulation and supervision on a lease not to exceed fifty years, under "such terms as will best protect the public interest." It was defeated.

Until such an amendment and laws to put it into effect are passed neither the State itself nor any lessee of the State may develop the Adirondack power potentialities where State lands are involved.

The waste goes on because what is essentially an economic matter has been thrown into the realm of politics. The interest of the people of the State is to have it taken out of the realm of

politics and the unused waters put to work. The State policy is in the statute books. It provides ample safeguards against exploitation and furnishes protection of the public's interests by the action of public officials.

Spier Falls power plant, on the Hudson.

III How The Waste May Be Ended

BEFORE the waste of water power may be stopped, official authorization of development projects must be given in such fashion as to protect fully the rights of the public—both those rights having their basis in ownership and those rights expressed in the law which assures the public safe and adequate electrical service at fair and reasonable rates.

A different set of conditions governs the development of each major project.

In 1910 a treaty was negotiated between the United States and the Dominion of Canada acting through the British Government concerning the waters of the international boundary streams—the Niagara and the St. Lawrence. That treaty declared that "no further or other uses or obstructions or diversions, whether temporary or permanent, of boundary waters on either side of the line, affecting the natural level or flow of boundary waters on the other side of the line, shall be made except by authority of the United States or the Dominion of Canada within their respective jurisdiction and with the approval, as hereinafter provided, of a Joint Commission to be known as the International Joint Commission."

This Joint Commission has jurisdiction over all cases involving the use or obstruction of the waters. Equal and similar rights in the use of the water is guaranteed to each of the signatories.

On the International section of the St. Lawrence no power development may be made which has not the authorization and approval of the State of New York and the Province of Ontario; and which has not the authorization and approval of the United States and the Dominion of Canada, finally approved by the International Joint Commission. The State of New York and the Province of Ontario must act together in exercising their rights to make possible a power development; no license, lease or grant by either of them will be effective without the concurrence of the other. That means that they must agree on the details of any plans for construction, maintenance and operation of a power development

project. Their concurrent action will not be effective without authorization of the United States and the Dominion of Canada, with the final approval of the International Joint Commission.

The Water Power Commission has jurisdiction to represent the State of New York as one party to such an agreement with the Province of Ontario. The Federal Power Commission has jurisdiction to represent the United States in making such an agreement with the Dominion of Canada.

The treaty of 1910 sanctioned the diversion of 56,000 cubic feet of water a second from the Niagara River above the Falls for power production. This was divided 36,000 feet to the Canadian side and 20,000 feet to the American side. Approximately 1,200,000 horsepower results from the use of that water on the two sides of the river.

America's share of the water, having been used once, is returned to the river just below the Falls. By reason of the physical characteristics of the river, it can be used for power purposes a second time, and utilized to produce 200,000 horsepower. For this project authorization by the State and by the Federal governments, through the State Water Power Commission and the Federal Power Commission, will be required. Apparently concurrent authorization by the Canadian authorities will not be necessary, though approval by the International Joint Commission would be.

A further diversion of water from the Niagara River above the Falls for power purposes, now discussed and needed if growing power demands are to be met, would, however, require a treaty amendment and possibly further action by the four sets of officials. and approval by the International Joint Commisssion.

In the Adirondacks, complete realization of the power possibilities of various streams by whomever made would require, first, amendment of the State's constitution as was proposed in 1923. Thereafter it would require authorization of the individual development projects by the State Water Power Commission.

When, and how, this waste of power shall be stopped depends, then, on public opinion and action by public officials. Action depends on determination to consider the matter in the light of benefits to be realized by the public from putting the water to work.

Stillwater—a modern storage reservoir on the headwaters of the Beaver River. Its waters are stocked with trout; its shores are scientifically forested; and summer camps, rapidly being built around it, will make it a popular resort.

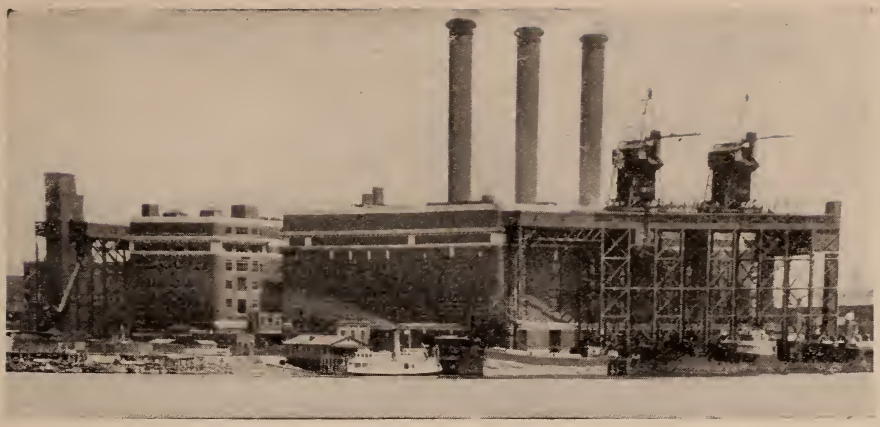
IV What Water Power Will Do In New York State

LARGE industries are moving from Eastern States to the South where raw materials and favorable conditions of labor and taxation are associated with abundant low-priced power. New England, alarmed at its loss of cotton spindles, is busy planning for a progressive lowering of its power costs. The Empire State can profit by study of these examples. An ample supply of low-priced power must be continued to serve existing industries and to attract new ones. If scientific development of water power resources on a large scale is undertaken, New York need fear no competition by any other State in industrial expansion.

From the day when steam first began to run machinery, water power has been in competition with steam. Water power is developed and placed on the market for two reasons.

Water power, first, is developed because it can be sold successfully in competition with steam-generated electricity, which means at somewhat lower prices. Second, it is developed because every horsepower year of hydro energy produced avoids the necessity of burning annually from seven to ten tons of coal or its equivalent in oil, gas or wood to generate that amount of energy.

There is a limit to the ability of water power to compete with steam-generated electricity. It may be unable to compete because its development would be too costly, or because the power site is too far from possible markets. The actual cost of the electricity at the power house is not a large item in the total cost of electrical service. With water power, the average power-house cost of the electric energy is about one-fifth of the cost delivered to customers for use—that is, the cost of transmission, distribution and service is approximately four times the cost of the power itself. The same general proportion holds good for steam-generated electricity, except the item of transmission. A steam station can be built any place where there is a railroad to haul in coal and large quantities of fresh or salt water are available for condensing purposes. So the transmission costs to the power markets can be minimized. With water power, the power has to be made where Nature creates it,



Hell Gate Station, which is now supplying about a billion kilowatt-hours of energy each year.

and if that is too far from the possible markets, it may be cheaper to use steam-generated power. In that case a particular power site will go undeveloped or will be developed only when its power can be used economically as part of a power reservoir from various sources.

The electricity supplied to the people of New York State, outside of New York City, is furnished largely by a great power system, the accomplishment of recent years. This is the result of cooperative operation of many companies of independent ownership. Plants producing electric energy from steam and hydroelectric plants are interconnected by transmission lines so that the energy produced forms a reservoir from which it is drawn for distribution to homes and factories in hundreds of communities according to the local needs. In New York City there is a local system formed by the interconnection of the generating plants of the various electrical companies, which is not yet connected with the State system.

This interconnection has saved many millions of dollars in amount of capital investment, amount of reserve generating capacity and total of operating expenses compared with what would otherwise have been required; and the people of the State have shared the benefits of these economies. In its annual report for 1925, the Public Service Commisssion of the State of New York said:

"Consolidations and extensions of electric plants have continued throughout the past year and have invariably been followed by an

improved character of service and quite frequently by immediate reductions in rates or readjustments which have operated to the benefit of the public. During the past year 54 corporations have filed schedules voluntarily reducing the rates for electricity. In the majority of cases the reductions have been substantial. Many of them have been made possible by consolidation and increased efficiency therefrom, others have resulted from the improvements in the art which have increased the use of electricity, thereby giving a greater revenue from the same capital investment, or have decreased the cost of operation."

In 1925 the people of New York State used in round numbers ten billion kilowatt-hours of electricity, which was one-sixth the consumption of the entire country. At the present rate of increase, the use in 1930 may be estimated conservatively to be well over 16 billion kilowatt-hours, and in 1935 about 26 billion kilowatt-hours. In all probability it will reach 30 billion kilowatt-hours by that date.

Hudson Avenue Station in Brooklyn,
one of the newest of the great coal-burning plants.

This huge quantity of electric energy must be produced, because New York State will not be permitted to lose its position of pre-eminence in industry. It will be produced, either from steam, which means coal and oil, or from water power. The more there is produced from water power, the greater will be the conservation of coal. But if the needs of 1930 and 1935 are to be met without a notable increase in coal burning by the electrical industry over the present consumption, there must be as soon as possible the beginning of comprehensive and scientific development of those water powers not now working for the public.

A water power plant cannot be built over night, even one comparatively small in the general plan of power development. If all official authorization necessary were obtained so construction work could begin tomorrow on what seems the most immediate project at Niagara, current could not be put on the wires for three years—perhaps a little better, if construction records were broken. When construction begins on the St. Lawrence project, five years' time will be required before power can be delivered.

By every requirement of efficiency and economy, these unused water powers, if and when developed, must become a part of the interconnected system in the State.

Projects of the magnitude of those contemplated at Niagara and on the St. Lawrence require the expenditure of such huge sums of money that unless a maximum production of power can be obtained and all that power can be used all the time, the cost would be too great to warrant development. But as a part of the great interconnected system, these developments could be made and utilized economically and to the great advantage of the public. The great volume of Niagara and St. Lawrence power would be "firm power." That is, it would be produced with very slight variations in quantity hour after hour, day after day, year in, year out, because there is so little variation in the stream flow. Its natural, economic use, therefore, is to supply the steady demands for power which every utility company has to meet. But besides these steady demands technically known as "base loads," utility companies have to meet irregular or excess demands known as "peak loads." These come at various times, according to the community's conditions of working and living, and the peak loads of

different cities and sections of the State do not coincide in time. Usually the maximum power demands are fifty per cent higher than the average demand. Without interconnection, by which power sources take advantage of the diversity in time of peak loads, each local plant would have to maintain generating capacity sufficient to meet its peak, about fifty per cent of which would be idle most of the time. This obviously would increase greatly the unit cost of the electric power produced.

If the great St. Lawrence project were to be operated as an isolated plant (by the State or any other owner) instead of as a part of the present interconnected system, it would prove needlessly expensive as a power producer. It would have to waste fifty per cent of its power all the time, or have fifty per cent of its generating capacity idle most of the time. But Niagara and the St. Lawrence operating full-time and balanced by the generating capacity (both steam and hydro) elsewhere in the State-wide power system, can be used economically and make their low-cost power widely available.

The electrical industry's broad plan of water power development calls for the utilization of Niagara and St. Lawrence power for base load and of the power from interior streams for peak loads. Inland streams are seasonal in flow, with high water in Spring and low water in Summer and Fall. Developments which could take full advantage of the Spring high water would be too large—therefore too expensive—for periods of low water. To remedy this condition, building of storage reservoirs for stream flow regulation is necessary, and this has been undertaken on certain rivers also in order to prevent disastrous floods. The place of such rivers in power production is valuable, even though they cannot be depended on for base power. They are put to work when needed. When they are not working, the storage reservoirs fill up again. Through such intermittent use, fullest value is obtained from them.

Niagara and St. Lawrence power will be produced to supply the needs of industry and commerce. It will run mills and factories, quarries, brickyards, hotels, stores and office buildings and other establishments having large power requirements fairly stable in their hours and conditions of use of the power. It will furnish the motive power for city and interurban transit systems. It will be available for electrification of railroads now using steam, and its availability will undoubtedly be an element in hastening the general electrification of railroad mileage in this State. Some of the

St. Lawrence power may ultimately find its way to New York City, though it may never displace steam power as the main source of electricity in the metropolis. Some of the Niagara and St. Lawrence power will be used on the farms and in farm houses around the State, hastening the time when electricity will do their work wherever it can be used economically.

High Falls power plant, on Beaver River.

V Rebuilding the St. Lawrence

THE project for development of the St. Lawrence contemplates what amounts to a reconstruction of that great river. It has been described as "building a second Niagara on the St. Lawrence." It is, in fact, the first step in a vision of a St. Lawrence rebuilt for the two co-ordinated purposes of power production and improved navigation, neither interfering with the other. It involves engineering problems and tasks of a magnitude heretofore never undertaken in work of this nature. Carrying it out will demand technical and financial resources of the highest order.

The Great Lakes, enormous storage reservoirs constructed by Nature, have an area of 90,000 square miles, into which is gathered the rainfall over a territory of 200,000 square miles. On its way to the sea this water has been partially harnessed at Niagara. Some of it has again been put to work at Massena on the St. Lawrence, but for power purposes the flood of mighty waters is still available at other sites as it has been during the centuries. From its head down to Montreal the river has a drop of 220 feet, of which 200 feet are capable of development for power. On the St. Lawrence the entire flow of water may be utilized, while this may never be at Niagara, because diversion of all the water for power would wipe out one of the scenic wonders of the world.

Completely developed, the St. Lawrence is estimated to be able to yield 5,400,000 horsepower, of which 2,400,000 would come from the international section of the stream and the remainder from that part which flows wholly through Canadian territory.

Three companies are now seeking the necessary authority to make this development—the New York and Ontario Power Company, the American Super Power Corporation and the Frontier Corporation. The latter company is owned by the General Electric Company, the Aluminum Company of America and the E. I. Du Pont de Nemours Company and has already made a preliminary investment in the St. Lawrence project of approximately $7,000,000. It is estimated that the total cost of developing the international section of the river will be approximately $240,000,000. The Company securing official authorization necessary will have the task of raising its share of the money and the greater task of assuring

Perspective drawing of the mighty dam and power-houses proposed for rebuilding the St. Lawrence. The whole structure must be built on the river bed, despite the unceasing drive of the current. The canal in the background will care for present navigation; but when the river is made navigable for vessels of deep draught new locks would be constructed on the American side.

the distribution of the 1,200,000 horsepower credited to the United States. It will have to sell this power before it can begin to receive any revenue on the investment.

Forty-two miles east of Ogdensburg lie Long Sault Rapids, an unnavigable stretch of seething, boiling waters, around which on the northern side of the river is a canal for navigation. One of the plans contemplated by the Frontier Corporation provides for a power plant in the stream at Barnhart Island. Across the river at the foot of the Island it is planned to build a dam 1,930 feet long and 130 feet from base to crest. Running upstream, the wings of this dam would support two power houses, each taking in water to be converted through turbo-generators into 1,200,000 horsepower of energy. In the middle of the dam would be the gates to control the level of the great pool of water which would be formed, forty miles long, giving an 83 foot head for power use, and for the handling of the ice-floes which a bitter Northern Winter creates.

While this enterprise unquestionably represents a great financial undertaking the projectors feel confident that their experience and resources, financial and technical, will enable them to win success. It is expected that the cost of power developed on the international section of the St. Lawrence will be comparable with the present cost of power at Niagara Falls. On that basis power may be sold to transmission or distributing companies at comparatively low rates. The prices charged by the distributing companies will naturally vary according to the distances of the points of use from the source of power and the distribution expense incurred. The ever increasing demand for Niagara power indicates that St. Lawrence power will not fail to find a ready sale when distributing companies are able to furnish it to their customers.

The physical difficulties of this construction project are enormous. Cofferdams of a size yet unattempted will have to be built on the river-bed against a flow of water more than five times the amount hitherto conquered in such work. There will be no periods of low water in which to work—the flow of the St. Lawrence varies so little that there will be no respite for the engineers and the construction gangs. In Spring there will be the ice hazard to encounter. The Northern Winter creates great ice-fields which, breaking up with warmer weather, rush down the river current at a rate of more than 10,000 tons a minute. That is the equivalent of a train-load every fifteen seconds. At least four times during the construction period this must be met and overcome. And each year there-

Winter ice jam in the St. Lawrence where the proposed dam is to be built.

after, during operation of the power plants, it must be met, and the ice so handled that it will be kept away from the intakes which conduct the water to the great turbines.

The construction work can be completed and the plants ready to produce electricity in five years from the beginning of work. Construction camps—which will be cities in themselves—will have to be built on each side of the river, with sleeping accommodations, mess halls, offices, hospitals, recreation centers. Special railroad connections to carry the construction material will have to be run in to the location.

While the building of the great dam is going on, another gigantic piece of construction unparalleled in the history of the electrical industry will be undertaken in New York State. The electrical energy produced from the waters of the river will be as valueless to humanity as the rushing waters themselves until it can be carried where it can work. There are no factories and few houses near the site of the dam, and it is unlikely that any great industrial community will grow up there such as has come into being at Niagara Falls. The country round about is sparsely settled and labor would have to be imported. Moreover, existing railroad facilities are rather limited.

So the power will have to be sent to the places where labor is, where factories may be enlarged and new ones built and where transportation facilities exist to handle their output. To carry the power to the places where it can go to work, an enormous high-

voltage transmission system will have to be built and connected to the present system whose lines make a network over New York State and its neighbors on the East, West and South. Plans have been made for such a system reaching from the St. Lawrence to the doorway of New York City—the largest high-voltage transmission system yet projected. Its connections will reach out East and West, so that the power from the St. Lawrence will mingle with the power from Niagara and, added to that from the Adirondacks and from steam stations in New York and adjoining States, will form the greatest power reservoir on the American continent.

Three north-and-south units in this transmission system are planned, over rights of way 50 or 75 miles apart, to carry the energy at 220,000 volts. The cost of this transmission system is estimated at just under $100,000,000 and does not include the cost of entry into New York City.

From the standpoint of economy and service it is essential that all generation, transmission and distribution of power should be co-ordinated to the maximum degree. In order to utilize base water power efficiently, to secure the advantages of diversity of loads in various communities and to utilize existing steam stations for maximum economy, it is essential that the supply and distribution of power should be under a co-ordinated directing force. Such control of operations would effect a saving in operating costs and invested capital aggregating many millions of dollars annually. In addition, the successful sale of power, its introduction into established industries and its application to new industries can be effectively accomplished only under conditions of flexibility and adaptability which are possible where the control and direction of the generation, transmission and distribution of the electric energy are co-ordinated as an operating and business entity, conditions impracticable of attainment where there is a divergency of interest between two or more of these elements of the service.

VI The Niagara That Is, and Is To Be

THE story of Niagara is an account of what is, and what is to be. From Niagara the people of New York State already get more hydroelectric energy than from all other water powers developed in the State. From this same source the territory served gets the lowest priced electric service in the State. It wants more, and could use more to advantage.

Niagara Falls is unique, both as a wonder of Nature and as a producer of power. Because it is so marvellous a spectacle it is the heritage of the world, not alone of the two countries whose territory it divides. For that reason its full potentialities for power production will never be realized. To make hydroelectricity with the greatest efficiency water must be diverted from the Niagara River above the Falls and run through power-house turbines. Complete utilization of the water for power would leave the Falls dry, which is not even considered. It would also leave no means of handling the great quantities of ice which moves out of Lake Erie and down the river in Spring. Nevertheless, more power could be produced from Niagara's waters, and eventually, undoubtedly, will be, in accordance with plans which make full provision for an improvement of Niagara's scenic beauty, and provision for carrying off the ice, and thus increase the cataract's practical service to humankind.

The only question is when official permission to bring all this about will be granted.

The waters of the Great Lakes pour down the Niagara River at the rate of somewhat more than 200,000 cubic feet a second, average flow year in and year out. There are two cataracts, divided by Goat Island, the American Falls with a crestline of 1,000 feet and a drop of 167 feet, and the Canadian or Horseshoe Falls with a crestline of 3,000 feet and a drop of 162 feet. Six per cent of the water passing over the Falls flows over the American cataract, ninety-four per cent over the Horseshoe Falls.

From Lake Erie to Lake Ontario, the Niagara River falls 338 feet. In one mile of its course, through the upper rapids and over

Niagara from an airplane. Below the Bridge is shown the plant of the Niagara Falls Power Company on the American side of the river.

the Falls there is a drop of 220 feet, and in the lower rapids there is a further drop of 94 feet, making a total drop in five miles of 314 feet. If all this fall could be utilized, with the full flow of the river, there would result around six million horsepower.

Power production at present is limited by the amount of water which may be diverted above the Falls under treaty between the United States and Great Britain. That treaty, promulgated in 1910, allows a total diversion for power amounting to 56,000 cubic feet of water a second, 20,000 cubic feet of which is allotted to the American side and 36,000 to the Canadian.

Until 1917, diversion on the American side was limited to 15,600 cubic feet a second under act of Congress, but when the World War came with its tremendous demands on manufacturing establishments of every sort, the Government called for plans for the prompt development of the remaining 4,400 cubic feet of water which might be used under the treaty. The result was a consolidation in 1918 of the power development interests on the American side under the name of The Niagara Falls Power Company, the construction of a new power house and the speedy development of 100,000 horsepower.

This company is now using, under license of the Federal Power Commission, all the water except 275 cubic feet a second, which may be diverted on the American side. From this water it produced in 1925 a total of 2,583,572,610 kilowatt-hours of hydroelectric energy which was distributed in sixteen counties in Western and Central New York, extending to Syracuse on the east and to Jamestown on the west. The transmission lines which carry this power are interconnected with the systems in Pennsylvania so there may be an interchange of power from Niagara for power from the coal fields when necessary. The Niagara Falls Power Company has installed generating capacity on the American side totalling 557,500 horsepower, of which 105,000 horsepower is reserve capacity.

Two possibilities exist for additional power production at Niagara. One is to obtain official permission for a further diversion of water above the Falls. The other is to make a second stage development to use water already used by the existing power plants and returned to the river below the Falls, under the present Inter-

Building the pressure tunnel which carries Niagara's waters to giant turbines.

national Treaty. Application for a license for this second stage development has been made to the State Water Power Commission by the Lower Niagara River Power and Water Supply Company, and is now pending.

This project contemplates the building of an intake at the foot of the Maid of the Mist Pool, just above the Michigan Central Bridge, carrying the water underground nearly three miles through two pressure tunnels, each 35 feet in diameter, and utilizing it at a power house at the foot of the lower rapids. These tunnels would follow, approximately, the course of the New York Central Railroad tracks around the lower rapids. They would utilize the 94-foot drop of these rapids. The water would produce 200,000 horsepower.

It is estimated that this project would cost about $40,000,000. The company already owns the property necessary for the intake

and the power house, and it is prepared to go ahead with the work as soon as the necessary official permission is granted. The tunnels would be built one at a time, and a part of the total output of power contemplated could be on the wires in three years, or perhaps even less time, while construction work on the second tunnel was in progress.

The other possibility for further power production at Niagara contemplates negotiation of a treaty giving permission for further diversion of water above the Falls, and is part of a project to stop the suicide of the Horseshoe Falls which is now taking place. Because of the action which must be taken by the governments concerned before final authorization for development is given, this development seems more remote than the second stage project.

The water which pours over the Horseshoe Falls is eating away the middle of the rocky rim of the cataract at the rate of about seven feet a year. Year by year the Horseshoe is being converted by this erosion into a V-shaped trough through which the greater part of the water passing over the Falls is discharged. Thus the crest of the Falls is being made longer and more irregular and the arms of the Horseshoe are being left dry in spots, and the tremendous rush of water through the growing trough in the middle of the Horseshoe progressively lessens the beauty of the Falls. This situation has been studied for a long time by various official bodies and plans for remedial works have been proposed. These include two main points: the building of submerged weirs or artificial islands in the river channel above the Falls, to deflect some of the water from the trough in the middle of the Horseshoe to the arms, now bare in spots, and a reduction of the flow over the Horseshoe. Engineers who have studied the matter say that the two items, in combination, will restore to the Horseshoe its beauty of former times, and incidentally will make available a considerable additional quantity of water which may be used for power production.

It is estimated that 100,000 cubic feet a second of the river's flow could be diverted above the Falls, leaving ample volume, with the reconstruction suggested, for handling the ice-flow in Spring and for beauty. The engineers point out that the American Falls, over which only six per cent of the water passes, evenly spread because of the numerous small islands in the channel above the Falls, are more beautiful than the Horseshoe with its great quantity of water, irregularly distributed, eating away the rim of the cataract

and creating a mass of spray which sometimes too greatly obscures the view of the Falls.

The diversion of 100,000 cubic feet of water each second above the Falls would make available for power production 44,000 cubic feet a second in addition to that now used. How that would be divided between the American and Canadian sides of the river would depend on the treaty which would sanction such additional diversion and authorize the reconstruction work for the preservation of the Horseshoe. If it were evenly divided, 675,000 horsepower more could be generated on the American side.

Plans have been prepared for this over all development if and when official permission is granted. An intake would be built in the upper river and two huge pressure tunnels would convey the water under the city of Niagara Falls and adjacent town of Lewiston about five miles to a power house built at the foot of the lower rapids directly adjoining the power house proposed for the second stage project. The Niagara Falls Power Company now owns or has rights for the use of all the property necessary for this route. Such development would utilize the full 314-feet drop of the river from the upper rapids to the foot of the lower rapids. It would cost, it is estimated, $60,000,000, which is about half the sum, for each horsepower produced, which the contemplated second stage development would cost. From the engineering standpoint, therefore, it is more desirable than the latter, though neither would interfere with the other.

To make possible this "overall" development, there would be necessary an amendment of the treaty between the United States and Great Britain for the additional diversion of water from the Niagara River, and an agreement on the remedial works which are regarded as part of the general plan. Beyond that, licenses would have to be obtained authorizing the use of the water by the power company. It is estimated that construction work for the full utilization of 22,000 cubic feet of water a second in this overall development could be completed in five years from the time it was authorized.

VII Inland Streams—Flood Prevention and Power

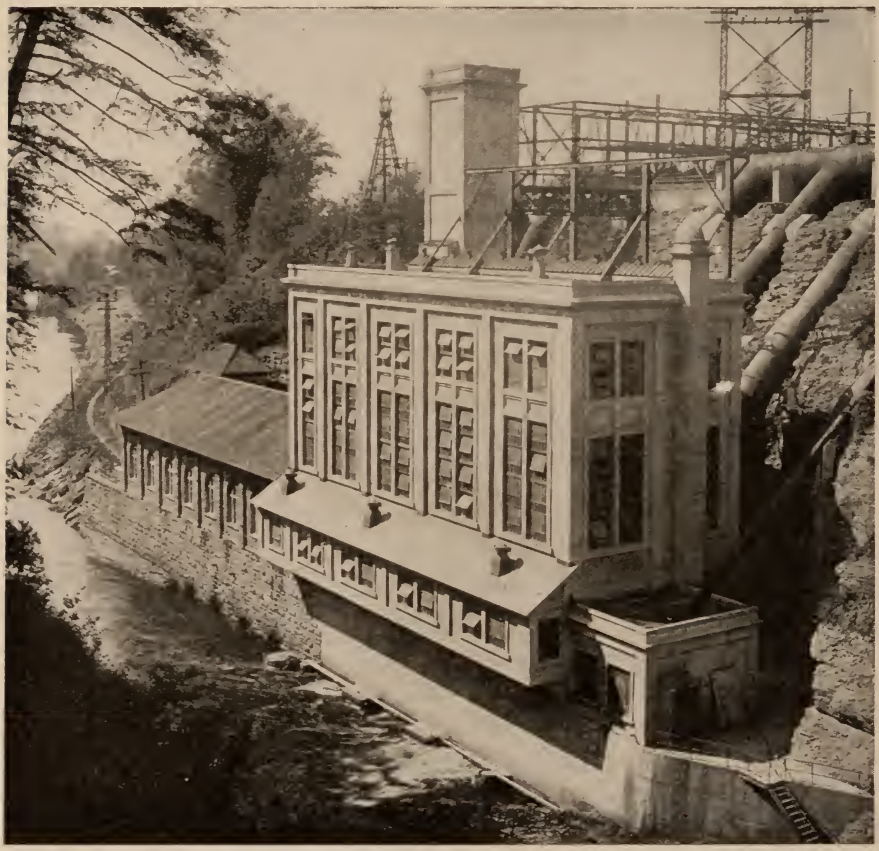
IN addition to the water power now developed by the electrical utilities and manufacturing companies, there are potential water powers on the interior streams of the State—the Hudson, the Genesee, the Delaware, and the Black, Raquette, Grasse, Salmon, Oswegatchie and others—shown by various surveys to be capable of producing approximately 1,000,000 horsepower if fully and scientifically developed.

Development up to date has been almost entirely by private interests owning power sites and riparian rights. Complete development of water powers on the interior streams depends on the building of storage reservoirs. They are all streams of seasonal flow, with disastrous floods on many of them in Spring, and with low water on all of them in Summer. Spring flood waters could be impounded in storage reservoirs and released in time of low water with benefit on two counts: flood damage would be done away with, and power production would be increased, both by a regulation of water flow at existing power plants, and by the creation of power at new sites. More than fifty such storage reservoirs are needed, which would make possible the production of power at more than 100 modern plants utilizing the water with greatest efficiency.

Building of these reservoirs in the Adirondacks is prevented by the constitutional provision against the flooding of forest lands. The Constitution permits the building of reservoirs on not to exceed three per cent of the forest preserve lands for municipal water supply and for the regulation of streams. Under laws enacted according to this provision, two River Regulating Districts have been established—the Black River Regulating District and the Hudson River Regulating District. Reservoirs have been built which regulate the floods of the Black River and its tributary, the Beaver, and have considerably increased power production. Under the jurisdiction of the Hudson River Regulating District, work is being done on the great Sacandaga Reservoir which will largely do away with the floods which do so much damage in Albany and neighboring communities, and will greatly increase the power value of the lower Hudson.

These River Regulating Districts are State agencies. The reservoirs are paid for by assessments levied against property and municipalities benefited by their construction according to the proportion of benefit resulting. The increased value of power rights below the reservoirs carries the bulk of the payments. The direct beneficiaries pay the entire cost. Neither the public treasury nor the taxpayer at large is called on for a dollar of the cost.

Of all the interior streams the Hudson has the greatest power possibilities. Power development on its upper reaches, however, is estopped because use of State lands is involved. The Sacandaga project on the lower reaches, being carried out by the Hudson River Regulating District, will cost about nine million dollars for the reservoir alone, with a further expenditure of thirty million dollars for power plants and generating machinery. It will produce



Trenton Falls power plant, near Utica.

120,000 horsepower. A huge dam is to be built at Conklingville on the Sacandaga River just above its junction with the Hudson, which will create a lake 22 miles long, containing 30,000,000,000 cubic feet of water. The reservoir will be the third largest in the country. The stored waters, released, will increase the river's minimum flow from 700 cubic feet a second to 3,000 cubic feet a second. Three new power pants are to be built to utilize the water, two others will be reconstructed and additional generating capacity will be installed in fifteen more.

The Genesee in Western New York, one of the worst flood streams in the State, has large power possibilities, now partially utilized at Rochester. It is estimated that the scientific development of the river with storage would produce approximately 100,000 horsepower. This, however, is prevented by the deed of gift which transferred the beautiful Letchworth Park, with its three falls near Portage, to the State.

Incomplete development of the Genesee by the building of dams and storage reservoirs outside the Park is possible. Work is now in progress on a project at Caneadea, sixty miles from Rochester, which will permit a considerable degree of stream regulation and flood control. It is probable that completion of this undertaking will be followed by the building of a dam near Mt. Morris, below the Park, creating an artificial lake fifteen miles long which would hold back from 75 to 90 per cent of the flood waters. This project would yield 15,000 horsepower at Mt. Morris and by equalizing the flow of the river create 22,000 additional horsepower at the hydro-electric plants at Rochester. This lake would have great scenic beauty and would really be a pleasure resort supplemental to Letchworth Park itself, since it is planned to have it open to the public for boating and fishing.

The Delaware, fully developed, could yield approximately 300,000 horsepower. Utilization of its power possibilities, however, would involve the rights of three States it touches—New York, Pennsylvania and New Jersey. Extensive and expensive storage, on lands in New York State, would be required. The Delaware is being considered as a source of drinking water by New Jersey and New York City. Moreover, utilization of the river for power would require re-location of a considerable section of the main line of the Erie Railroad, which runs right along its shore. Complete development of the Delaware for power, therefore, seems unlikely for a good many years, if it ever proves feasible.

It is estimated that approximately 150,000 horsepower which might be developed on the upper Hudson and other streams in the Adirondacks are tied up indefinitely by the Constitutional provision against use of State lands for power purposes. This, however, does not accurately measure the obstacle to comprehensive power development of the interior streams interposed by the Constitutional provision. A stream may, for example, have on it five power sites. Ownership of land to be flooded for the storage reservoir and the first, third and fifth power sites may be vested in individuals. The land at the second power site may be owned by the State, and a part of the land necessary at the fourth may be State-owned, the rest owned by individuals. The cost of the reservoir will be so large that unless all five power sites are developed, each bearing its pro-

A modern steam station at Amsterdam, used to balance water power in the interconnected system.

portionate share of the cost, development would be uneconomic. Until the Constitution is amended as was proposed, the State may not participate in such an undertaking, nor may it license private individuals or corporations to use its lands for reservoirs, power plants or transmission lines. Thus development of a considerable part of the power resources of the interior streams will be postponed until the Constitution is amended or until the demand for power is so great that the partial development possible through individual ownership is economically justifiable.

There is much misunderstanding about what would result if all the projected storage reservoirs in the Adirondacks were built, power plants erected and transmission lines built to link them into the existing interconnected system. The argument has been made that the reservoirs would be unsightly and unhealthy and the Adirondacks be spoiled as a pleasure park and a health resort for the people. Experience with storage reservoirs for water supply, flood prevention and power purposes has proved this to be untrue. Actually a good deal of the land in the Adirondacks which would be flooded is now neither beautiful nor especially health-giving.

Reforesting a hillside. Power companies plant trees to protect their watersheds.

Growth of 18-year old Scotch pine—result of electrical company reforesting along the Beaver River. Approximately four million trees have been planted by one company.

It is often swampy, full of stumps of old trees, a breeding ground for mosquitoes. Storage reservoirs would make much of it more sightly than at present, since the modern reservoir is a beautiful lake, covering ground from which stumps have been removed and with shores well preserved in their wild state or reforested. The Stillwater Reservoir built by the Black River Regulating District is an excellent example. It replaced a rather disreputable lake, its shores lined with stumps and snags, with a fine body of clear, deep water which has been stocked with fish. On its shores scores of camp sites are being laid out. Thousands of young evergreen trees have been planted around it, and it is expected to be one of the favorite pleasure resorts of that section of the North Woods.

A modern hydroelectric plant is not ugly. Present-day practice gives much attention to making it beautiful and harmonious with its surroundings. It is clean, makes little noise in operation, and requires only a few men to operate it. A high-tension transmission line, while perhaps not beautiful except to the engineer, is not unsightly and in forest country would seldom be seen, because it would be built on a right-of-way as remote as possible from roads and traffic. Moreover, instead of being a detriment to forest country, transmission rights-of-way have proved in the national forests to be very useful as firebreaks and fire patrol lines. They are completely cleared of trees and underbrush, frequently 100 feet wide, and they are patrolled by utility company employees regularly. They form an important link in the chain of protection against the fire menace to the forests. The Federal forest policy contemplates and permits a reasonable amount of cutting of trees for roads, transmission lines, and power purposes.

VIII The Necessity for Action

THE public of New York State has an interest in having the water powers developed as soon as it is possible to put them to work.

Every store, every factory, every farm, every home has an interest in the prompt development of these water powers. More power and lower-priced power must give a mighty forward impulse to the State's well-being. It represents more production, more pay, more prosperity. That must be the public's first and greatest interest in having the wasted waters used.

The public's interest is in the fact that such development presents possibilities of savings in the amount expended annually for use of electricity in New York State. This does not mean that every community would have its rates lowered or that every customer would receive smaller bills for the electricity used. It does mean that the production cost of the total amount of electricity which will be used in New York State for many years to come would unquestionably be less than its production cost would be without the utilization of the water power. And under public regulation of public utilities which exists in this State, the benefits of this lower production cost would be passed along to the public and the sum total of the electric bills would be less than if the water powers were not developed.

This has already been demonstrated in that section of the State now served chiefly by Niagara power. The public there—not every user of electricity, but the public as a whole—pays for its electric service a price less than the price in other parts of the State. Considering the fact that the rates cover taxes paid to local, State and Federal governments, which amount to a dime in each dollar spent for electricity, the public in the Niagara district gets its electric service for less money than the public of Ontario pays to the governmentally owned and operated electric systems there for service from Niagara power.

The public's interest is in the vast saving in coal which would result. America's coal fields are not inexhaustible. As long

as rain falls and water runs down hill, the water powers can be used with no exhaustion of Nature's resources.

Another phase of the public's interest in substitution of the use of "white coal" for black lies in the fact that it would hasten the freeing of industry generally from the hazards of dependence on coal. The coal trade has been, for years, and probably will be for many years to come, subject to interruptions of production and distribution. Industry is rapidly becoming electrified, but is not yet so generally electrified as it assuredly will become with the availability of an added volume of low-priced hydroelectricity.

The public's interest is in the fact that a substantial revenue will be derived from license fees and taxes for the State, and taxes for local communities. The State has now an income of more than $500,000 a year from fees and rentals for water power it owns. The fees from the new Niagara and the St. Lawrence projects would very greatly increase this, and would be obtained without the expenditure of one cent of State funds or any risk by the State if licenses for the projects were granted to the applicants.

The power projects discussed in this book require an estimated investment of around half a billion dollars. Every dollar so invested will represent an income from taxes to the locality where the physical property exists. It will represent, also, an income to the State and Federal governments from the electrical business it makes possible. In 1924 electrical company reports to the Public Service Commission showed that they paid taxes amounting to $16,789,162. Of this sum approximately $10,000,000 went to the local communities, more than $1,500,000 went to the State, and the balance to the Federal government. Utility taxes are increasing largely each year. Beyond the benefits to the public from the taxes paid by the companies because of the huge investment necessary for the water power developments and the increase in the electrical business would be others—taxes amounting to many thousands of dollars a year paid by individuals on the income derived from the securities held by them in the companies making the developments, and taxes paid by businessses locating in this State because of the new supply of low-cost power.

So long as official authorization of the beginning of work on these projects is postponed, waste continues. The public is losing an opportunity to obtain its supply of electricity on more favorable

terms. The State is losing substantial revenue it might be receiving. The world is losing coal which took a million years to create.

The electrical industry in New York State is ready to act, if permitted. It can produce a systematic, comprehensive development of the unused water powers which will utilize their fullest value; and it can, through its knowledge, experience and personnel, create markets which will absorb the huge volume of power produced.

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